The Muscle Shoals Project

Florence, Alabama

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by

GEOGRAPHY DEPARTMENT

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I.

THE TENNESSEE RIVER

BEFORE the Muscle Shoals Project was proposed, five years ago, little was known by the public at large of the Tennessee River. As tributary to the Ohio river, most people who thought of it at all, considered it a stream of scarcely secondary importance. As a matter of fact it is often the equal of the Ohio in volume, and second to few in steadiness of flowage.

The Tennessee, as may be seen by the sketch, has its origin in the Great Valley of Virginia, flows twice across the state of Tennessee and into the Ohio, 47 miles above the junction of that river with the Mississippi. It is navigable from its mouth, at Paducah, Ky., to Knoxville, Tennessee, a distance of 650 miles, with the single exception of the Muscle Shoals, lying in the Alabama counties, Lauderdale, Colbert and Lawrence. For a distance of 17 miles above Florence, the river is obstructed by a rocky bed of flint forming innumerable small islands, where the water is too shallow and swift for navigation. Within this distance, the incline in the river bed averages 7.6 feet per mile, and makes a total drop of 134 ft.

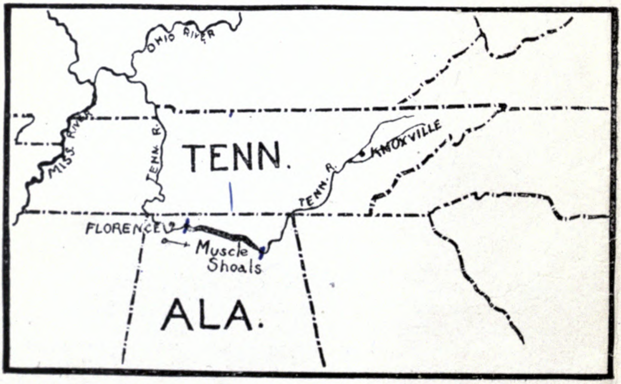
This fall, when concentrated by the two dams proposed, is capable of developing approximately 800,000 horsepower. With this power harnessed, it is estimated that enough electricity can be generated to send a useable current over 60,000 square miles. As to fuel saved by this enormous power, figures are roughly placed at 6,500,000 tons of coal annually consumed in securing equivalent power.

Not only may this inconceivable power be developed, but free navigation for a distance of 80

miles along the Muscle Shoals will be secured by the construction of the great locks in Dams 2 and 3, with a lift equal to 1 2-3 times that of the Panama Canal.

From Brown's Island to Florence, a distance of thirty-seven miles, lies the foundation for this enormous power. In places the current exceeds ten miles per hour and there are slopes as great as fifteen feet per mile. The fall for the entire section is about one-hundred thirty-four feet. The width of the river varies between one thousand and nine thousand six hundred feet.

The shoal system is produced by a very hard, resistant stratum of flint limestone. On the shoals the bed of the river is of rock running across the stream in steps about one to two feet high, corresponding to thickness of flint. The flint bottom has prevented the river from eroding a deep channel, so, necessarily, it has spread over a wide bed. This flint bottom, besides causing the shoals and making possible the power, also furnishes an ideal foundation for a dam.



II.

LOCATING THE NITRATE PLANT

BEFORE the great European War the United States was dependent on Chili for nitrates. But, after the war broke out it was found desirable that we should take steps to manufacture our own nitrate. The government then began investigations as to suitable places.

Up to that time all plants of this kind were built on or near the Atlantic Coast. But now it was thought best to establish a "Safety Zone," within the limits of which, munition plants could be located without danger of interfernce from enemies. This Zone should be west of the Alleghanies and east of the Sierra Nevada and Cascades and should be at least three hundred miles from any border of the United States. From this viewpoint the Muscle Shoals lay well within the "safety zone." This part of the Tennessee is at its nearest point, over three hundred miles from the Gulf or the Atlantic.

Another reason for the selection of this site for the nitrate plant lies in the climatic conditions. There are certain times of the year when many rivers freeze and cannot be used. At no season is the Tennessee obstructed by ice.

In the location of a great enterprise like that of the nitrate plant at Muscle Shoals, a primary consideration is that of power. From a financial point of view, power is next to labor, the largest expense item. As an example of this the Steam Power House, which was built in connection with the Plant in order to furnish power until the Wilson Dam should be completed, uses about 1500 tons of coal in twenty-four hours when in full operation. This coal at present prices could not be secured for less than $4,500 or $6,000. This would make the cost of the electric current including other items

and costs of power house operation about $.024 per kilowatt per hour. The fact that the power wasting in the Tennessee River could be harnessed and made to produce the power at an estimated cost of $.003 per K. W. was the greatest factor in determining the location of the Nitrate Plant at Muscle Shoals.

In considering the location for a plant of such gigantic proportions as that at Muscle Shoals, next to power a most important factor is transportation. For if a plant lacks adequate facilities for moving its finished products and for the bringing in of its raw materials it cannot hope to compete with rival concerns which possess these advantages.

Muscle Shoals has first, a natural transportation artery in the Tennessee River over which waterway connections may be made with the entire Mississippi Valley. A second advantage is its connection with the main line of the Southern Railroad which has a network of lines in the South and reaches important centers in the Northeast. A branch of the Louisville and Nashville connects this location with the North. Still another facility for transportation, which in this time of motor efficiency is not to be overlooked, is the several highways connecting Muscle Shoals with the surrounding cities.

The comparatively level character of the country surrounding the district many also be named as an advantage for transportation, because it facilitates the building of railroads.

III.

THE STEAM POWER HOUSE

THE Steam Power House, completed, will have a capacity of 135,000 H. P. It was erected to supply power for operating the Nitrate Plant until the Dam could be built. The power developed at this plant will be 60 per cent of the power now developed at the Niagara Falls hydro-electric plants, and approximately equal to the installed capacity of the Keokuk development. This power house contains one of the largest steam turbines ever built, having a capacity of 80,000 H. P. The steam is furnished by twelve Stirling Boilers with normal rating 15,000 H. P. each. The plant under full load will consume about 1500 tons of coal per day. 240,000,000 gallons of water per day will pass through the condenser in summer for condesing the steam. 6000 tons of structural steel and about 5,000,000 brick have been used in the construction of this enormous building.

THE NITRATE PLANT

(Two and one-half miles East of Sheffield on South side of river.)

THIS is one of the largest Nitrate Plants in the world to be successfully operated. It also has one of the three largest successfully operated Rotary Lime Kiln plants in the United States, with capacity of 800 tons per 24 hours.

There are twelve carbide furnaces, each requiring about 10,000 H. P. electric current to operate. The total capacity is 300 tons of carbide per 24 hours.

There are 1536 cyanamid ovens, 1000 of which can be in continuous operation. The liquid air plant is five times larger than any other installation of its kind in the world. Nitrogen is extracted from the air at a rate of one half million cubic feet per hour at normal pressure.

There are two complete plants for the manufacture of nitrate, No. 1 and No. 2. No. 2 is ready for operation. The cost of these two plants has been estimated at approximately $74,000,000. Their operation is said to require three thousand skilled workmen.

IV.

WILSON DAM

(Three miles East of Florence.)

THE culmination of the great Muscle Shoals Project, lies in the completion of the dam by means of which enormous power is to be developed.

Its construction is now about one third completed. The structure extends between bluffs on the north and south sides of the river, a distance of approximately 4500 feet. It is divided into three parts, each for a different purpose.

1. At the north end connecting with the boat channel of the river are the two great locks.

2. A spillway section, 2890 feet long, in which are to be 63 gates through which overflow water it to pass.

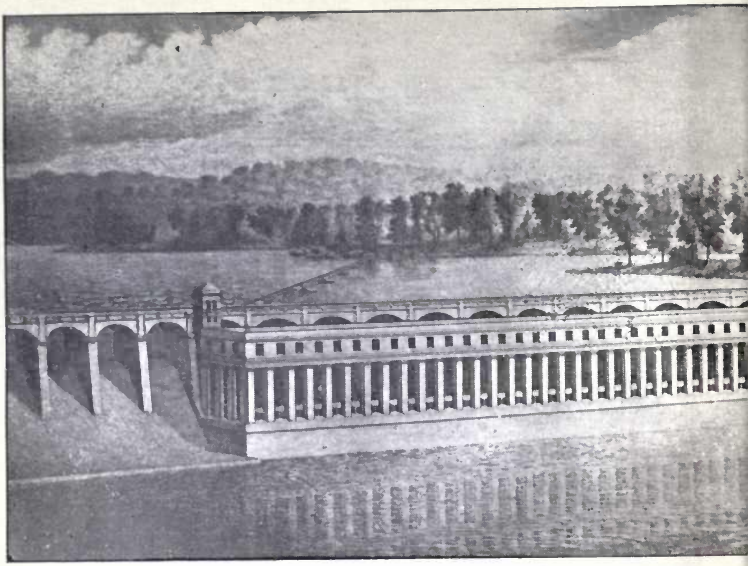
3. The power house section on the south side comprising in addition to the dam a building for housing the generating machinery. This section is 1,184 feet in length.

All three sections are to be surmounted by a concrete arch bridge, a part of the highway connecting the two sides of the river.

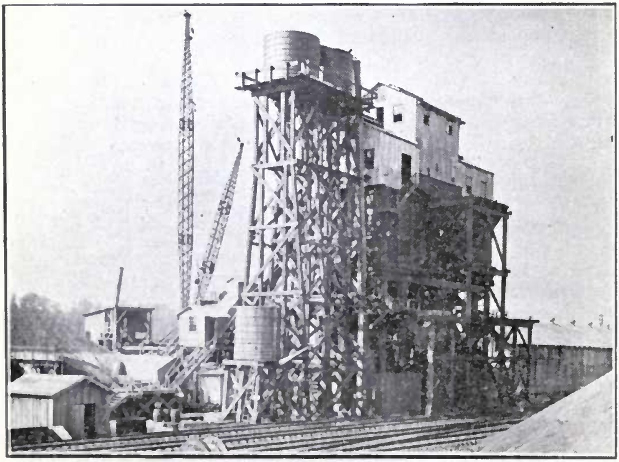
The following figures will give some idea of the dimensions of a structure which when completed will contain more masonry than the great Assouan Dam of the Nile, hitherto the largest in the world.

Width of dam on bedrock	101 ft.
Width of apron or underwater extension	59 ft.
Height of Dam	91 ft.
Height of bridge floor above bedrock	116 ft.
Width of bridge	23 ft.
Length of Dam	4500 ft.
Length of locks, each	300 ft.
Width of locks	60 ft.
Total lift	91 ft.

At least two years will probably be required to complete the construction. It has cost $17,000,000

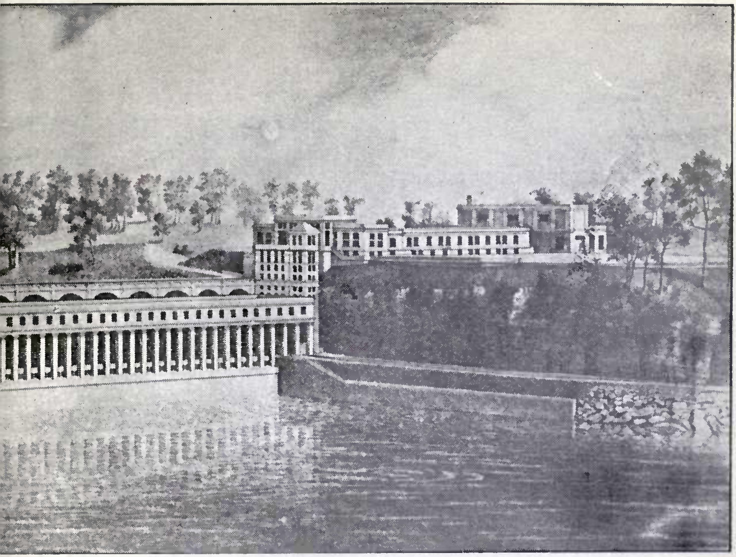


Section of Wilson Dam showing

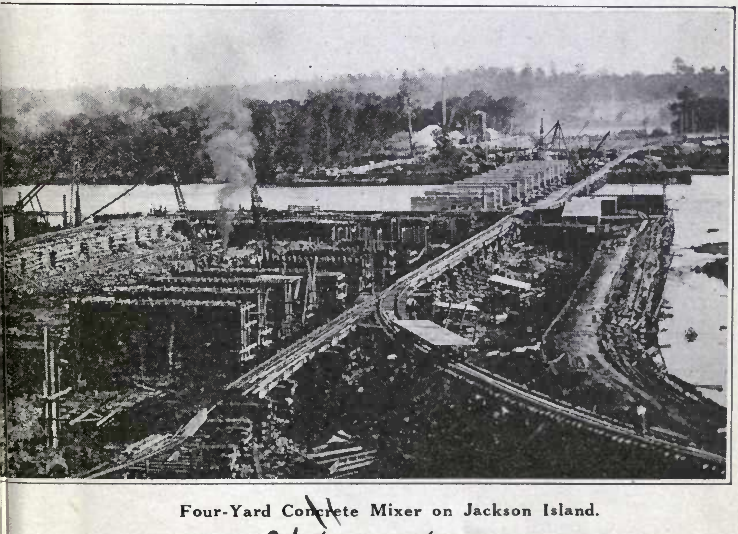


View of Coffed Dam No. 1 and of No. 3 on Jackson Island.

Opposite page



s it will appear when completed.



Four-Yard Concrete Mixer on Jackson Island.

Opposite page

up to date, and estimates for completion are place at $23,000,000 more, or a total of $40,000,000.

This project is now under the superintendency of Col. W. J. Barden, Corps of Engrs., U. S. A., and U. S. Ordnance Dept.

A corps of officials and guards are retained to look after the protection of $104,000,000 worth of property, until the Plant is completed and put in operation, viz:

1. Six Cofferdams, which will provide for progressively uncovering the foundation of the dam and power house.

2. A construction bridge, carrying four standard guage railroad tracks for the supply and handling of materials. This bridge is built on concrete piers and runs parallel to the axis of the dam, on the downstream side.

3. Ten large traveling tower cranes, which will operate along the construction bridge and deposit the concrete in place.

4. Three concrete mixing plants, one on each bank, and one on Jackson Island in midstream. Their capacities are as follows:

North Shore—two 2-yard mixers.
Jackson Island—two 4-yard mixers.
South Shore—two 2-yard mixers.

5. A dredging fleet of two prower suction dredges (15 inch), two towboats and fifteen barges, which dig and transport sand and gravel sufficient for 1 1-4 million yards of concrete. An auxiliary crushing plant also provides facilities for alternative use of the excavated rock, which can be crushed for aggregate.

6. 27 1-3 miles of construction railroad, and much rolling stock, including twenty-five locomotives, sixteen locomotive cranes, ten steam shovels, four large air compressors.

The concrete mixers discharge into bottom-dump buckets placed two on a flat car. These are hauled from the mixers by 25 ton dinky engines out on the construction bridge to a point just opposite the concreting operations. The big crane waiting for its load lifts a full bucket of concrete, turns and

dumps it into place inside the forms, then whirls back with empty bucket. A continuous chain of cars will keep the big cranes busy. All forms are of lumber of the cantilever type and built up in sections, six to twelve feet high at a time. Thus the dam will be formed of layers, some six feet thick, well bonded together throughout. A considerable number of large blocks of stone, called plums will be utilized, and will afford additional bond between layers. Vertical expansion joints will be provided every forty-six feet.

The under lay, or foundation is the "Lauderdale Chert", or limestone rock. The first concrete going into permanent construction was poured on May 7, 1920, when the first section of the apron of the dam was commenced, inside the cofferdam on Jackson Island.

SUPPLIES

In order to carry out the construction of the dam on schedule it is vital that material and supplies of every description shall be available on time. The quantities involved are indicated by the following examples:

CEMENT—1,500,000 barrels, at an average of 1,800 barrels a day.

SAND—500,000 cubic yards at an average rate of forty-five 20-yard car loads a day.

GRAVEL—1,000,000 cu. yds, at an average rate of ninety 20-yards car loads a day.

LUMBER—25,000,000 feet, board measure.

COAL—125,000 tons.

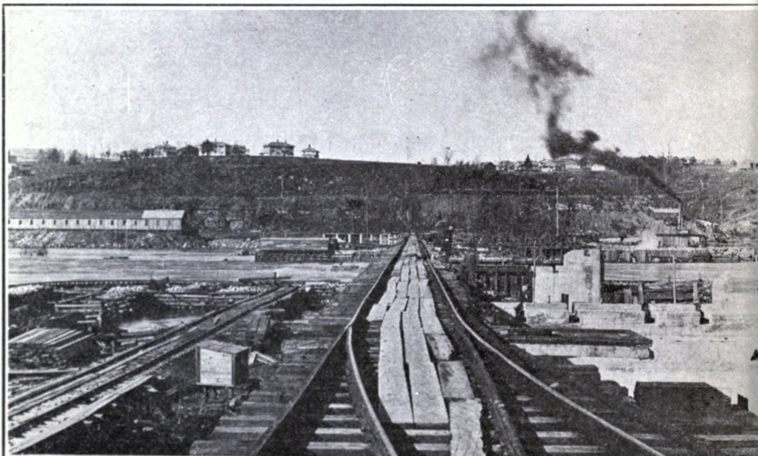
The width of the Tennessee at the site of the Dam is over four thousand feet; the height of the pool level to which it is proposed to raise the water is nearly 100 feet above the river bed. Its volume of 1 1-4 million cubic yards of masonry will make it rank first among the American river dams, and larger in point of masonry content than the famous Assouan Dam on the Nile.

The dam will be of solid concrete masonry, with its upper face vertical, and a curved lower face over which the discharge water of the Tennessee will

flow smoothly. Its crest will be broken every thirty-eight feet by piers connected by 38 ft. arch spans. These piers will support an imposing bridge with a roadway 23 feet wide. The discharge will be regulated by gates 18 feet high, which comprise the upper part of the spillway section of the dam and which will be manipulated by hydraulic operating machinery, and in emergencies, by two gantry cranes traveling on the bridge.

The power plant portion of the dam will be at the south end, and will consist, in addition to the dam and roadway,of 18 power unit sections and a shore section. Auxiliary structures on the shore will include switching house and operators' quarters, machine shop, a two million gallon per day pumping plant, a high tension switching yard, and various small structures necessary for housing apparatus and materials needed in the operation of the plant.

The penstocks, through which water is conveyed



View of Bluff on North Side.

to turbines, are of the triple passage type, the combined area of these openings forming a water passage to each turbine 15 feet high by 40 feet wide. The turbine runners are approximately 14 feet in diameter, have a speed of 100 revolutions per minute and develop 30,000 horse power each when operated at full rate capacity. The generators are 29 feet in diameter and have a power output of 25,000 K. V. A. at 12,000 volts, 60 cycles. These power units have an overall height of over 45 feet and will weigh, complete, over 600 tons each.

Measurements of the Dam

Length—From lock to south abutment, about 4,350 feet.

Height—81 ft. for masonry; 96 ft. to top of gates; 120 ft. to top of bridge.

Thickness—Bottom 101 ft for Dam proper; 160 ft. including apron.

Volume of masonry—Total over 1,260,000 cu. yds. including power house.

Locks—Two, north end of dam.

Length of locks—(available) 300 ft.

Width of locks—60 ft.

Height of lock walls—58 ft. (These vary in places.)

Extent of pool upstream—14.7 miles.

Acreage of land overflowed—About 14080 acres with pool at normal level.

V.

ELECTRIC POWER AND LABOR AVAILABLE

THE immediate availability of electricity and labor had its influence on the location of the Wilson Dam.

Electric Power for construction was available from the Alabama Power Company from their Lock 12 hydroelectric development on Coosa river and the Warrior River steam plant, the former being 140 miles distant, while the latter is 90 miles south of Muscle Shoals.

Power is supplied from these plants over a single circuit, three-phase stranded copper transmission line. The cables are each one half inch in diameter, and are in a horizontal plane.

The power is transmitted at a pressure of 110,000 volts and is transformed to 13,000, 2,300 being used for local distribution at Wilson Dam.

The population on the north side of the river was, during the period of construction, about three thousand, constituting a community independent of the adjoining towns of Florence, Sheffield and Tuscumbia. There are also many buildings in these towns which can be used to advantage. On Pine Ridge, in the western part of the camp proper, there are fifty new dwellings; the number when this home section is finished will reach one hundred eight. There are seventy-five temporary dwellings on other hills and along the main roads. Some are modern homes, equipped with modern conveniences.

VI.

THE USES OF DEVELOPED POWER

CONSERVATION in regard to water power has a great meaning; we cannot prevent the water from running down rivers; whether it is used or untouched, the same amount runs down the next day. Water power conservation lies in its use. If the force of the water is harnessed it is made to do work that otherwise would be done not at all or by coal. The use of water is the conservation of coal.

This power to be developed at the Muscle Shoals will be used, when completed, for business or for military purposes if necessity arises. Let us consider the business side of the proposition.

The one remedy for soil exhaustion is found in an adequate supply of nitrogen, the basis of all food supply. It is one of the principal elements of fertilizer, the greatest necessity and labor-saving agency in the United States today. In times of peace, this power should take from the air sufficient nitrogen to supply a suitable grade of fertilizer at a cost it is expected much less than that of Chilean Nitrates.

The department of agriculture recently issued a report stating that the power developed at the Muscle Shoals promised more than simply a supply of nitrogen fertilizer. It shows how phosphoric acid in Tennessee phospate rock and potash of our southern states can be concentrated so that compounds may be formed containing 70 per cent more plant food than is found in our present compounds.

With the power developed the country at large may have that of which farms stand in greatest need—nitrogen fertilizer, at reasonable prices.

"Since the value of fertilizer has been realized," to quote from the geographer, Ellsworth Hunt-

ington, "people have sought for means of utilizing the unlimited supply of nitrogen in the air. Success was finally obtained by means of strong electric currents which cause the atmospheric nitrogen to unite with other substances. Much power is required for the electric discharges, so that the process is commercially profitable only where power is cheap. The cheapest known power is from waterfalls.

"The work of obtaining nitrogen from the air may seem remote from the lives of people who live in cities. Yet it concerns every one of us. The farmers supply us with most of the material for food and clothing, which play so large a part in the lives of all. If the farmers do not have rich soil and cannot raise their crops abundantly, the price of food and clothing goes up, and we all suffer. Therefore it is of the greatest importance that the farmer's need of good fertilizer should be fully met."

The mighty Tennessee has swept over its flinty bed for ages. It remains for this generation to say whether or not it is to prove a boon for industrious millions, or go on flowing in its old savage way, defying industry and commerce.

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